Global Coordinates of the SNS Accelerator Complex

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In this note, the global coordinates of a few key points of the SNS accelerator complex are determined using the official coordinate system. Due to the fact that the lattice files of different parts don't necessarily overlap. Engineering drawings and design reports are used to bridge the gaps.

As described in SNS Accelerator Division Document Transmittal #JE-051800-01, the origin (Central Monument 00, MON00) of the coordinate system is located at the intersection of the plane that contains the linac and is perpendicular to the plane of the ring and the line that goes through the center of the ring and is parallel to the injection straight. The Z-axis is defined as the line that is parallel to the linac line, with its positive direction pointing towards the target building. The X-axis is the line that goes through the center of the ring with its positive direction pointing to the ring. The Y-axis is the line that is perpendicular to both the X-axis and Z-axis, with its positive direction defined in the way such that the three axes form a right-handed coordinate system. Due to the fact that the ring lies in the horizontal plane, the positive direction of the Y-axis points up. The coordinates of MON00 are defined as (20,000.0, 10,000.0, 2,000.0), in meters and the order of z, x, and y. The order and unit of the coordinates remain unchanged throughout the note.

There is no single lattice file that covers the entire accelerator system. Four lattice files cover the linac, HEBT, ring and RTBT, respectively. The PARMILA input file of the linac and HEBT (provided by H. Takeda) starts at the beginning of MEBT and ends at the end of HEBT. Yet only the part HEBT before the first dipole magnet can be used because PARMILA does not provide the global coordinates of devices. Nonetheless, it is very helpful to have part of the downstream line in the file, which is used as the interface between the two sections. The TRANSFORT input file of the HEBT (provided by D. Raparia) starts from the center of the first quadrupole magnet in the HEBT line (HEBT.QV1) and ends at the stripping foil location. The relative position and orientation between the end of the HEBT line and the midpoint of the injection straight of the ring are obtained from BNL/SNS Technical Note 076, D. Raparia and engineering drawing provided by J. Negrin. Specifically, the reference orbit at the end of the HEBT line is parallel to the injection straight and the position of the end of HEBT relative to the midpoint of the injection straight is (-0.14, -0.607, 0.046). The floor layout of the ring is obtained from the MAD input file provided by Y. Papaphilippou. The TRANSPORT input file of the RTBT line (provided by D. Raparia) starts at the first dipole magnet after the vertical bends and ends at the target. The relative position and orientation between the ring and RTBT are obtained from the engineering drawing provided by J. Negrin. At the beginning of RTBT, the reference orbit is parallel to the extraction straight (in X-Z projection). The position of the start of the extraction septum relative to the midpoint of the extraction straight is (0.0, -3.437611, -0.225415). The Y coordinate of the starting point is not very useful, because it is in the middle of the slope after the extraction kicker. After the vertical bend magnet RTBT.DV1, the beamline is leveled at the altitude of -0.2286 m (Y coordinate). Between the magnets RTBT.QH2 and RTBT.QV3, there is a vertical dogleg that raises the level of the beamline to -0.1826 m. Since the RTBT lattice ends at the front surface of the target, an extra 0.206096m (obtained from interface document provided by T. McManamy) was added to the lattice to reach the target center.

Last but not least, D. Raparia provided the lattice files (TRANSPORT input) of the linac, injection and extraction dump lines. The linac dump file starts at the beginning of the HEBT, the injection dump file starts at the foil and the extraction dump file starts at the beginning of the RTBT. Due to the fact that there are two beams in the injection dump line, the center of the line is defined as that which lies in between the two beams. Specifically, H^0 goes through INJBND3 with no bending while H^- goes through INJBND3 with 2.406422 degrees of bending. The center of the beam line is defined as the one that coincides with the centers of both beams before INJBND3 and is bent by 1.203211 degrees after it. Instead of 10 degrees bending marked in the X-2 drawing, the septum bends the reference particle (center of the beam line) by 8.796789 degrees.

With the information described above, the coordinates of any point on the reference orbit can be determined. Table 1 displays the coordinates of a few key points, whose locations are shown in Figure 1. Note that the coordinates of a magnet are those of the center of it. All magnets are aligned parallel to the X-Z plane. To describe the orientation of magnets in the X-Z plane, an angle phi is defined with respect to the Z-axis. The range of phi is [-180 degrees < phi $\leq$ +180 degrees] and a positive value of phi corresponds to a line with a positive slope. The angle phi is determined by the tangential vector in the direction of the magnet in the reference orbit, relative to the Z axis. All magnets before the first dipole magnet in HEBT are aligned along the Z-axis (phi = 0). Phi of the first quad in HEBT after the main dipoles equals to 81.24500 degrees. In the ring, phi of QVA12 is 90 degrees, QVC12 is -90 degrees. Phi of QVB12 is 0 degrees and QVD12 equal –180 degrees. Phi of the first quad in RTBT is –73.20140 degrees. Phi of the last quad in RTBT is –56.40152 degrees. Phi of the linac dump is 0, phi of the injection dump is 102.62252degrees and phi of the extraction dump is –73.20140 degrees. Additional coordinates can be found at http://www.sns.gov/APGroup/refTables/generalParams.htm .

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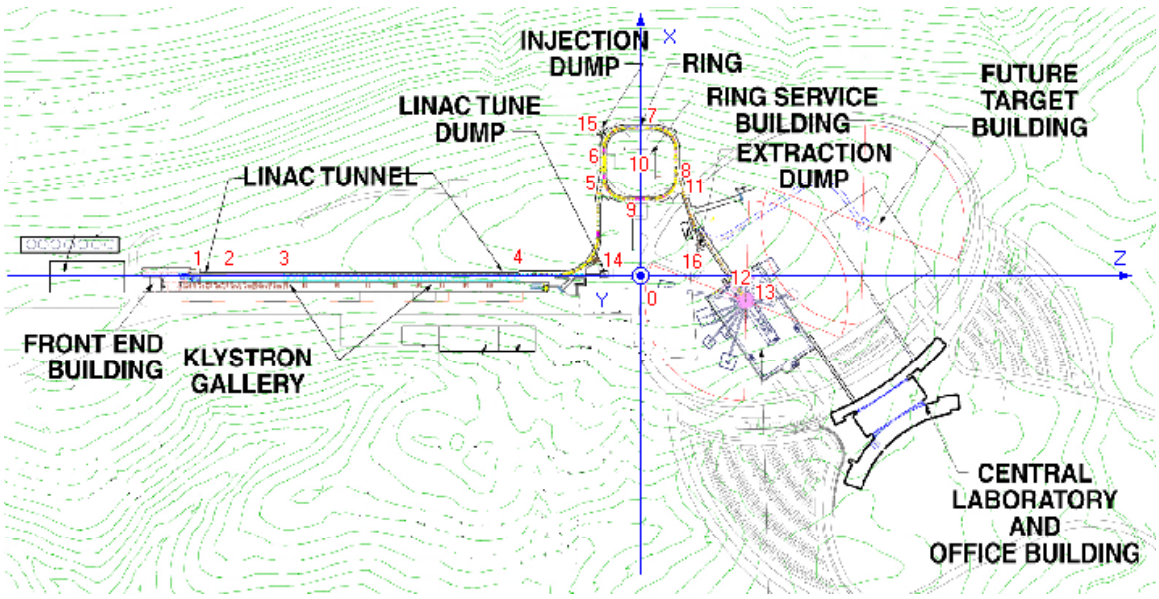

Figure 1: SNS site map with the key points marked

Table 1: Coordinates of key points along the reference orbit

#	Name	Location	Z	X	Y
0	Complex center	Central Monument 00 (MON00)	20,000.000000	10,000.000000	2,000.000000
1	FE end	Last quad in MEBT (QH14)	19,549.720844	10,000.000000	2,000.046000
2	DTL end	Quad between DTL and CCL	19,586.684608	10,000.000000	2,000.046000
3	CCL end	Last quad in CCL-SC Region	19,643.268832	10,000.000000	2,000.046000
4	HEBT beginning	First quad in HEBT (HEBT.QV1)	19,881.174844	10,000.000000	2,000.046000
5	HEBT end	Last quad in HEBT (HEBT.QH34)	19,963.886407	10,102.299981	2,000.046000
6	Ring section A	First quad after foil (QVA12)	19,964.669100	10,117.136220	2,000.000000
7	Ring section B	QVB12	20,006.525000	10,145.942120	2,000.000000
8	Ring section C	QVC12	20,035.330900	10,104.086220	2,000.000000
9	Ring section D	QVD12	19,993.475000	10,075.280320	2,000.000000
10	Ring center	Center of ring	20,000.000000	10,110.611220	2,000.000000
11	RTBT beginning	First quad in RTBT (RTBT.QV1)	20,036.790003	10,101.093420	1,999.771400
12	RTBT end	Last quad in RTBT (RTBT.QH30)	20,098.564565	9,982.566226	1,999.817400
13	Target center	Center of target	20,104.489012	9973.648848	1,999.817400
14	Linac dump	Center of the linac dump	19959.047845	10,000.000000	2,000.046000
15	Injection dump	Center of the injection dump	19,958.312420	10,142.496311	2,000.046000
16	Extraction dump	Center of the extraction dump	20059.017116	10027.467166	1,999.817400